Prevalence of the metabolic syndrome in Poland based on the new 2022 definition

Gilbert Artur Baćmaga[1]*, Natalia Dąbrowska[1]*, Alicja Cicha-Mikołajczyk[1], Piotr Bandosz[2], Krystyna Kozakiewicz[3], Andrzej Pająk[4], Magdalena Agnieszka Kwaśniewska[5], Arkadiusz Niklas[6], Aleksander Prejbisz[1], Piotr Dobrowolski[1]****

[1]Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion, National Institute of Cardiology, Warsaw, Poland
[2]Department of Arterial Hypertension and Diabetology, Medical University of Gdańsk, Gdańsk, Poland
[33]rd Department of Cardiology, Medical University of Silesia, Katowice, Poland
[4]Department of Epidemiology and Population Studies, Institute of Public Health, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland
[5]Department of Social and Preventive Medicine, Medical University of Lodz, Łódź, Poland
[6]Department of Hypertension, Angiology and Internal Disease, Poznan University of Medical Science, Poznań, Poland
**First two authors contributed equally and are first co-authors.*
***Last two authors contributed equally and are senior co-authors.*

Abstract

Background: Metabolic syndrome (MS) is a cluster of cardiovascular risk factors. In 2022 Polish experts proposed a new definition of MS. The aim of this study was to analyze the frequency of the MS based on the WOBASZ II cohort study (2013–2014) and compare it to that based on the previous definition.

Material and methods: The WOBASZ II study was conducted on a sample of 6170 Polish adults. The 2022 definition of MS includes: abdominal obesity, hypertension, impaired glucose metabolism, atherogenic dyslipidemia; MS is diagnosed if abdominal obesity and at least two other factors are present. The old definition based on the 2009 Joint Interim Statement included: abdominal obesity, elevated blood pressure, impaired glucose metabolism, hypertriglyceridemia, low high-density lipoprotein cholesterol; MS was diagnosed if at least three criteria were met.

Results: The prevalence of the MS in the WOBASZ II cohort study according to the new definition was 31.7%. Compared to the previous definition the prevalence of MS decreased significantly in men (42.8% *vs.* 29.2%; $p < 0.0001$) and no change was observed in women (34.6% *vs.* 33.7%; $p = 0.19$). Due to the change in criteria prevalence of the obesity component decreased in the Polish population from 65.9% to 44.0%; $p < 0.0001$. Atherogenic dyslipidemia became the most prevalent component (67.6%, an increase from 42.6%; $p < 0.0001$). High normal blood pressure/hypertension and diabetes/pre-diabetes components were present in 60.9% and 32.6% of respondents.

Conclusions: Despite that the estimate of the prevalence of MS according to the new definition is lower as compared to the previous definition, MS and its components remain widespread in the Polish population.

Key words: metabolic syndrome; abdominal obesity; hypertension; hyperglycemia; dyslipidemia; cardiometabolic risk factors

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Address for correspondence: Gilbert Artur Baćmaga, Department of Epidemiology, Cardiovascular Disease Prevention and Health Promotion, National Institute of Cardiology, Warsaw, Poland; e-mail: bacmaga.g@gmail.com

Introduction

Poland is classified as a country with high cardiovascular (CV) risk [1]. CV diseases are the main cause of mortality in the Polish population. In 2020 CV diseases were the cause of more than 42.6% of all deaths in Poland (41% of women and 33% of men) [2].

The co-occurrence of classic CV risk factors — obesity, elevated blood pressure, glucose metabolism alterations and atherogenic dyslipidemia — is determined as a metabolic syndrome (MS). The definition of MS has been revised over the years. The current Polish consensus from 2022 states that MS can be diagnosed in patients with obesity who meet two of three additional criteria: high normal blood pressure or hypertension, prediabetes or diabetes, elevated non-high-density lipoprotein cholesterol (non-HDL-C) level [3]. The previous diagnostic criteria, which were set out in the 2009 Joint Interim Statement endorsed, among others, by American Heart Association and International Diabetes Federation, included the presence of three risk factors among: obesity, elevated blood pressure, impaired glucose metabolism, decreased HDL-C levels, elevated triglyceride concentration. [4] It is worth mentioning that the definitions (2022 and 2009) differ in cut-off values and criteria for obesity and lipid disorders.

The aim of this study was to assess the prevalence of MS depending on the new definition based on the cohort of the WOBASZ II study (2013–2014) and then compare the prevalence of MS based on the new and previous definition. [5]

Material and methods

The WOBASZ II study was conducted on a representative group of 6170 participants aged 20 years and over who were randomly selected from the national register of population (PESEL database). Method of sampling has been described in detail elsewhere [5]. The number of participants met both World Health Organization (WHO) recommendations and European Health Examination Survey Manual suggestions [6, 7].

All the measurements were taken by trained nurses. Waist circumference was measured at the level of the navel, with an accuracy of 0.5 cm. Body weight was measured with an accuracy of 0.1 kg, using certified Beurer scales. An examined person was without shoes or outerwear. Height was measured with an accuracy of 0.5 cm, using either a height measuring rod or meter scale, depending on whether the examination took place at the examination center or the respondent's home, respectively. An examined person was without shoes.

Blood pressure was measured with an automatic blood pressure monitor, approved by the Association for the Advancement of Medical Instrumentation. A blood pressure cuff was chosen based on the arm circumference and the examined person rested 5 minutes in a seated position before the measurement was taken. Blood pressure readings were taken three times at one-minute intervals. For the analysis was used the mean of the second and third readings.

Blood samples were collected by trained personnel either during home visit or in the designated examination centers. Collected samples were centrifuged at regional centers and then serum was frozen at –20°C. Frozen serum was transported in the dry ice to the central laboratory where all laboratory tests took place. The following biochemical tests were performed: total cholesterol concentration, HDL-C concentration, low-density lipoprotein cholesterol (LDL-C) concentration, triglyceride concentration, glucose concentration. Non-HDL cholesterol concentration was assessed by subtracting HDL cholesterol concentration from total cholesterol concentration. Laboratory methods and equipment have been described in detail in the original article about WOBASZ II study. [5]

The questionnaire interview was used for acquiring data about medications taken. Questions included: names of medications, the reason for taking them, and the daily dose. Obtained data were processed at the national center.

In the 2009 Joint Interim Statement MS was defined as the co-occurrence of at least three of the following:

- waist circumference ≥ 80 cm in women or ≥ 94 cm in men;
- systolic blood pressure (SBP) ≥ 130 mm Hg and/or diastolic blood pressure (DBP) ≥ 85 mm Hg;
- fasting glucose ≥ 100 mg/dL or glucose-lowering treatment;
- HDL-C < 50 mg/dL in women or < 40 mg/dL in men or treatment with fibrates or nicotinic acid;
- triglycerides level ≥ 150 mg/dl or treatment with fibrates, nicotinic acid, or omega-3 acids.

The 2022 definition of MS states that obesity [waist circumference ≥ 88 cm in women and ≥ 102 cm in men, or body mass index (BMI) ≥ 30 for both sexes] is a necessary component and must be accompanied by at least two of the following:

Table 1. Comparison of two definitions of metabolic syndrome

2009 Joint Interim Statement			2022 Polish consensus		
Obesity	Waist circumference		Waist circumference		Obesity
	Men ≥ 94 cm	Women ≥ 80 cm	Men ≥ 102 cm	Women ≥ 88 cm	
			Or BMI ≥ 30 kg/m^2		
Elevated blood pressure	In-office SBP ≥ 130 mm Hg and/or DBP ≥ 85 mm Hg		In-office SBP ≥ 130 mm Hg and/or DBP ≥ 85 mm Hg		Elevated blood pressure
	Or on anti-hypertensive treatment		Or on anti-hypertensive treatment		
			Or home measurement SBP ≥ 130 mm Hg and/or DBP ≥ 80 mm Hg		
Impaired glucose metabolism	Fasting glucose ≥ 100 mg/dL		Fasting glucose ≥ 100 mg/dL		Impaired glucose metabolism
	Glucose-lowering drug treatment		Glucose-lowering drug treatment		
			Glucose ≥ 140 mg/dL after 120 minutes in OGTT		
			HbA_{1c} ≥ 5.7%		
Impaired HDL-C metabolism	HDL-C levels		Non-HDL-C ≥ 130 mg/dL		Atherogenic dyslipidemia
	Men < 40 mg/dL	Women < 50 mg/dL			
	Or treatment with: fibrates or nicotinic acid		Or treatment with: fibrates, nicotinic acid, omega-3 acids, statins, ezetimibe, PCSK9 inhibitor		
Impaired triglyceride metabolism	Triglyceride levels ≥ 150 mg/dL				
	Or treatment with: fibrates, nicotinic acid or omega-3 acids				

BMI — body mass index; SBP — systolic blood pressure; DBP — diastolic blood pressure; OGTT — oral glucose tolerance test; HbA_{1c} — glycated hemoglobin; HDL-C — high-density lipoprotein cholesterol; PCSK9 — proprotein convertase subtilisin/kexin 9

- SBP ≥ 130 mm Hg in-office measurement and/or DBP ≥ 85 mm Hg in-office measurements or SBP ≥ 130 mm Hg in-home measurement and/or DBP ≥ 80 mm Hg in-home measurement or anti-hypertensive treatment;
- fasting glucose ≥ 100 mg/dL or glycemia ≥ 140 mg/dL in 120 minute in an oral glucose tolerance test or glycated hemoglobin (HbA_{1c}) ≥ 5.7% or glucose-lowering drug treatment;
- non-HDL-C ≥ 130 mg/dL or lipid-lowering treatment [statins, ezetimibe, proprotein convertase subtilisin/kexin 9 (PCSK9) inhibitors, fibrates, nicotinic acid, omega-3 acids].

A comparison of those two definitions is presented in Table 1.

Results

In the Polish population use of the new definition of MS causes a decrease in the prevalence of MS (from 38.3% to 31.7%; p < 0.0001), significantly in men (42.8% *vs.* 29.2%; p < 0.0001) and did not change in women (34.6% *vs.* 33.7%; p = 0.19) (Fig. 1). Over a fifth of respondents meeting new criteria would be undiagnosed under the definition from 2009. On the other hand, over a third of those meeting the old criteria do not qualify as MS patients while using the new definition. Both definitions are met by 24.8% of the population (Fig. 2).

The changes in selected age groups were as follows: decrease in the age group 20–39 years (15.2% *vs.* 9.2%; p < 0.0001), decrease (45.2% *vs.* 36.8; p < 0.0001) in the age group 40–64 years and decrease (57.9% *vs.* 54.9%; p = 0.040) in the population 65 years and over. This data is illustrated in Figure 3. A particularly pronounced decrease in the MS prevalence was observed in men aged 40 to 64 years (51.4% *vs.* 34.3%; p < 0.0001).

Due to the change in criteria prevalence of the obesity component decreased in the Polish population from 65.9% to 44.0%; p < 0.0001, with a decrease both in men (60.9% *vs.* 37.4%; p < 0.0001) and in women (69.9% *vs.* 49.4%; p < 0.0001). Among those meeting the obesity 2022 criterion 92.9% fulfilled the abdominal obesity criterion, while 57.2% had BMI ≥ 30 kg/m^2 and both criteria were met by 50.1% of this group. The prevalence of atherogenic dyslipidemia increased in men (46.1% *vs.* 72.8%; p < 0.0001) and in women (39.7% *vs.* 63.5%; p < 0.0001) and in the overall population (42.6% *vs.* 67.6%; p < 0.0001). Those changes are illustrated in Figure 4. In the entire study population, non-HDL cholesterol levels ≥ 130 mg/dL without hypolipemic treatment was found in 60.0% of subjects, hypolipemic treatment in 15.3%, both in 6.5% (of those

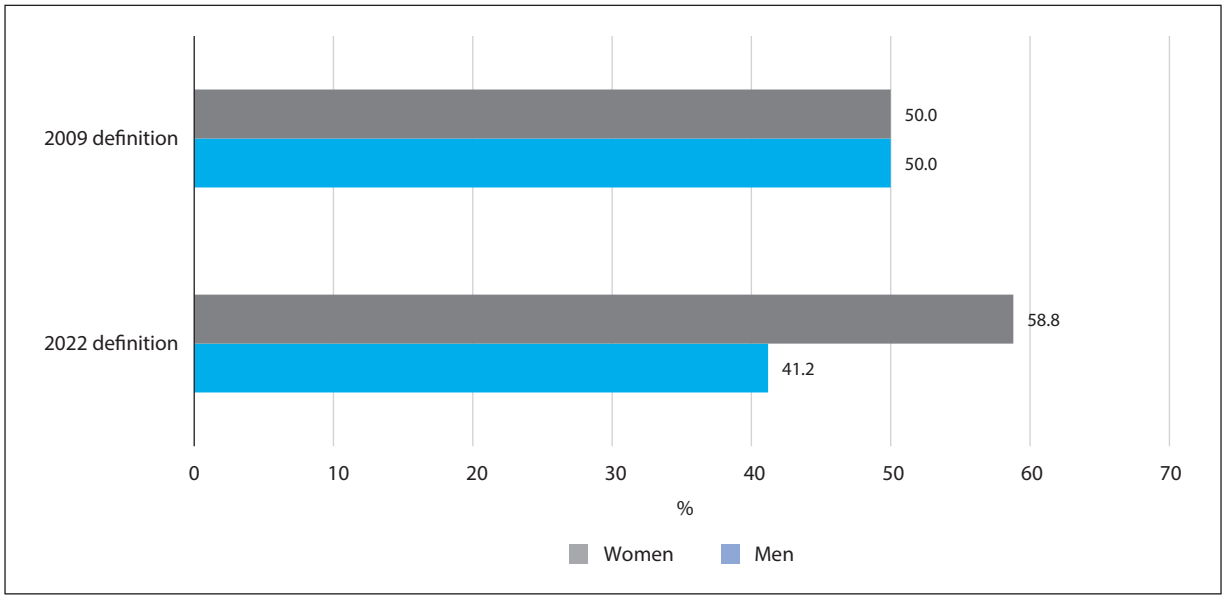

Figure 1. Sex distribution among the metabolic syndrome patients

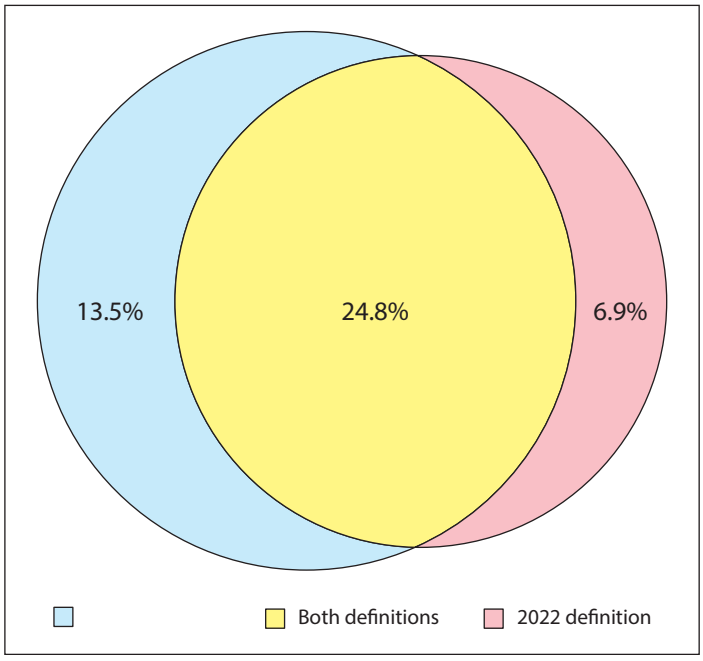

Figure 2. Respondents classified using the 2009 definition and the new 2022 definition. Not pictured: 3381 (54.9%) respondents who did not qualify for metabolic syndrome with either of the definitions

on hypolipemic treatment, 42.1% had non-HDL cholesterol levels ≥ 130 mg/dL). Among patients with metabolic syndrome as defined by 2022 consensus, 29.5% of patients received hypolipemic treatment, and 42.4% of them had non-HDL cholesterol concentrations higher than 130 mg/dL despite treatment. In the MS population, low HDL-C levels were present in 52.6%, whereas increased triglyceride levels were present in 58.7%. Both of those criteria were fulfilled in 32.8% of the MS population.

The prevalence of both hypertension (60.9%) and diabetes/pre-diabetes (32.6%) components did not change as the WOBASZ II study didn't include home pressure measurements or HbA1C level measurement which were included in the 2022

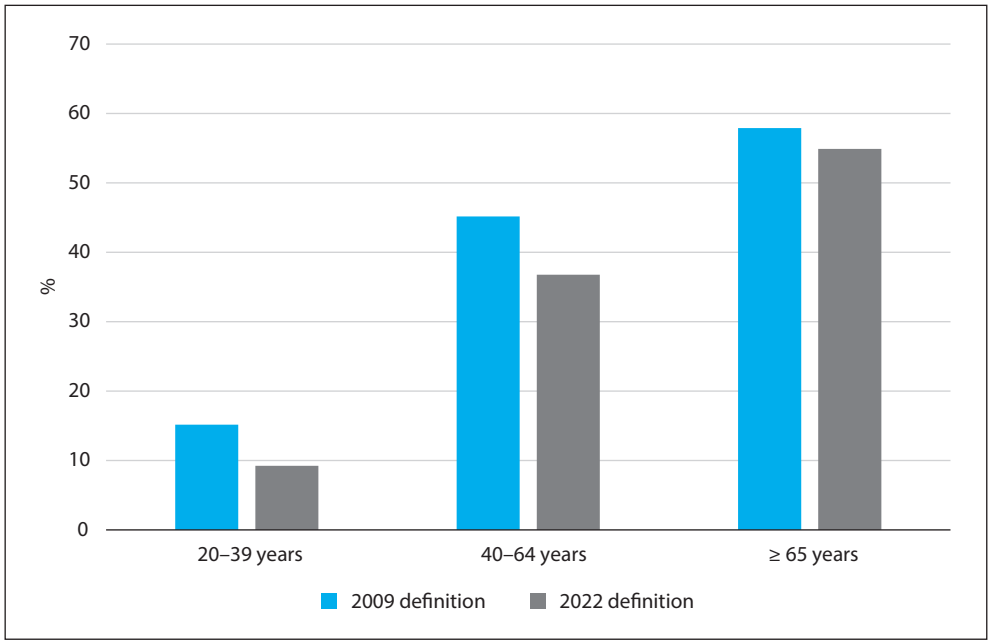

Figure 3. Comparison of prevalence of metabolic syndrome in the Polish population divided into age groups based on the used definition

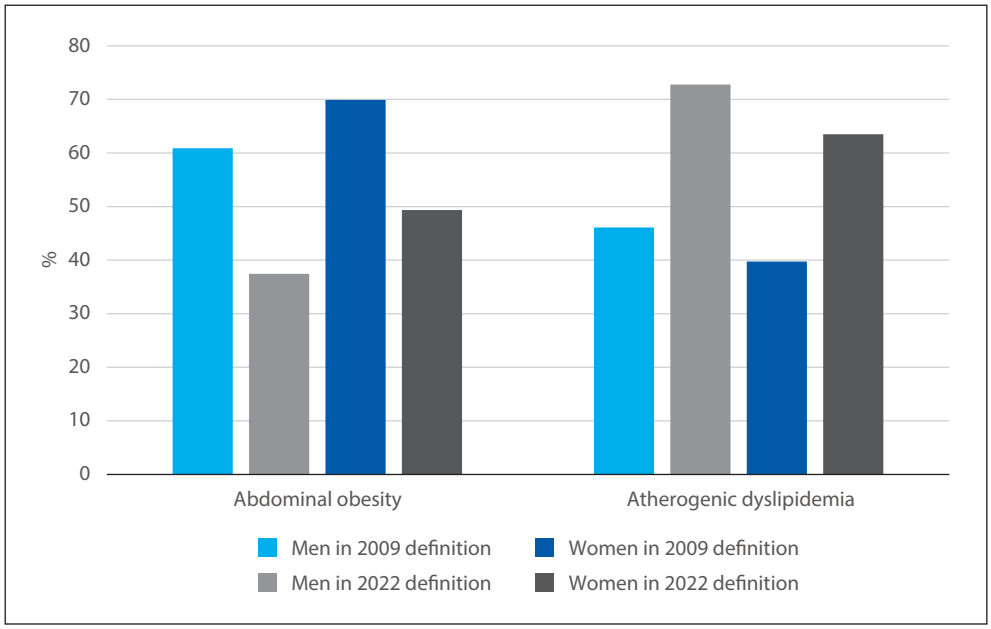

Figure 4. Change in prevalence of selected metabolism syndrome components in the Polish population based on the used definition

definition. The individual components of MS in the group of patients meeting the 2022 criteria had the following prevalence: atherogenic dyslipidemia 91.3% (non-HDL cholesterol levels without hypolipemic treatment 75.8%), high normal blood pressure or hypertension 93.9% (including hypertension 76.6%), and abnormal fasting glucose levels or diabetes 61.1%.

Discussion

Based on the analysis of WOBASZ II study results and use of the new definition, we see demography of MS patients has changed. The establishment of the new definition caused a small, but significant decrease in the Polish population meeting the criteria. Although the change may not

be very visible in the total population in clinical practice, it changed the prevalence among certain subpopulations. The difference is particularly significant among men — the number of men with MS dropped by almost a quarter. At the same time frequency of MS among the women population did not change. As a consequence, MS is more prevalent in the female population, which is a visible contrast when comparing the two definitions. Moreover, the sex distribution among metabolic syndrome patients underwent a major change which is shown in Figure 1.

According to the new 2022 definition the cut-off value for waist circumference was increased from 94 cm to 102 cm in men and from 80 cm to 88 cm in women. Moreover, it is now possible to fulfill the obesity criterion by having BMI ≥ 30 kg/m^2. Despite adding the BMI sub-criterion, narrowing down waist circumference cut-off values caused an overall decrease in respondents having this component (from 65.9% to 44.0%). It should also be noted that only 7.1% of MS population met the criterion of obesity due to BMI without having increased waist circumference simultaneously.

It should be noted that in the new definition, obesity is a mandatory component of the MS. The emphasis on obesity in the new definition stems from multiple studies showing that obesity is not only an independent CV risk factor but also a reversible cause of other comorbidities like glucose and atherogenic dyslipidemia as well as hypertension. [8][9]

An important change in criteria concerns atherogenic dyslipidemia. In the new definition non-HDL-C levels are evaluated instead of HDL-C and triglycerides concentrations. Most recent studies point out that non-HDL-C is a better marker of CV risk in comparison to HDL-C or triglyceride concentrations [10, 11]. Non-HDL-C is also a better marker of CV risk than LDL-C as it encompasses not only LDL but also all other atherogenic lipoproteins: very-low-density lipoprotein (VLDL), intermediate-density lipoprotein (IDL), chylomicrons, chylomicron remnants, VLDL remnants and lipoprotein(a) [12, 13]. Moreover, another modification to this criterion was the inclusion of patients taking all lipid-lowering drugs (including statins, ezetimibe and PCSK9 inhibitors) as opposed to previous diagnostic criteria of MS which listed only fibrates, nicotinic acid and omega-3 acids. This change is the cause of the increase among respondents meeting the lipid criterion. This increase can be mainly attributed to the widespread use of statins — 11.2% of the Polish population as indicated by Bandosz et al. based on the NATPOL II study conducted in 2011. Their use was most prevalent in the age group 60–79 years (32.2%). [14] The aforementioned changes are the cause for atherogenic dyslipidemia to be the most prevalent component in the studied population (67.6%), but on the other hand, they are now contained in one criterion. This can greatly attribute to change in the prevalence of MS, for example: someone with the obesity component and elevated triglycerides and lowered HDL-C levels would meet the 2009 definition, but does not qualify as MS patient in the new one. In the WOBASZ II cohort one-third of respondents with MS had both criteria fulfilled simultaneously.

The change in glucose impairment metabolism criterion has not found reflection in this analysis as the WOBASZ II study didn't include measurement of HbA_{1c} levels. As a consequence, the number of respondents fulfilling this criterion may be undervalued. The cut-off value in the new definition stems from American Diabetes Association guidelines [15] as The Polish Diabetes Association guidelines do not allow for diagnosis of pre-diabetes state based on HbA_{1c} level [16]. The case is similar with the hypertensive component: although the new definitions allows for the fulfillment of this criterion with at-home measurements, the scope of the WOBASZ II study didn't include those.

Hirode and Wong in their study [17] based on National Health and Nutrition Examination Survey (2015–2016) indicated a prevalence of 34.7% in the population of the United States of America. Meta-analyses show a prevalence of 33% in Brazil [18], 24.5% in the People's Republic of China [19] and 25% in the Middle East countries [20]. Although it's difficult to compare epidemiological studies in different countries due to differences in definitions and cut-off values, it is safe to say MS has become a global problem. WOBASZ II study results support the view it is a serious problem also in the Polish population, as over 30% of respondents met the new criteria of MS. Therefore, every effort should be made for prevention, early detection, and proper treatment of the components of MS. The emphasis should be put on lifestyle interventions as an unhealthy lifestyle is the foundation of comorbidities constituting MS.

Conclusions

Despite that the introduction of the new definition decreased the prevalence of MS in the Polish population, predominantly in men, MS remains com-

mon in Polish population. After the criteria changes, atherogenic dyslipidemia became the most frequent component of MS in the population and the prevalence of obesity component decreased significantly due to more restrictive waist circumference cut-off points. Adequate actions should be undertaken to prevent, diagnose and treat components of MS.

Data availability statement

Data set is available upon request.

Ethics statement

The Ethical Committee of the Institute of Cardiology in Warsaw approved the study protocol. All participants provided informed written consent.

Author contributions

G.B.*, N.D.* conceptualized the analysis, wrote the manuscript; A.C.M. performed the statistical analyses; A.P.#, P.D.# provided substantial supervision and worked on the final manuscript; P.B., K.K., A.P., M.A.K., A.N. took part in conducting the survey and preparing the database.

*These two authors contributed equally and are first co-authors.

#These two authors contributed equally and are senior co-authors.

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Conflict of interest:

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